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Descriptions of Iowa Uromyces

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DESCRIPTIONS OF IOWA UROMYCES.

BY J. C. ARTHUR.

Since 1876 there has been a systematic effort to gather information regarding the flora of Iowa, especially directed toward recording all species found in the state, with localities. Up to the present time the work has been confined to the phanerogamic part of the flora, and, in extending it to the lower orders, many difficulties are encountered, chief of which is the determination of synonymy. The following study of Iowa *Uromyces* is an outgrowth of this local cataloguing. It is an attempt to clear up the synonymy, and to give a uniform and sufficiently full specific description to permit accurate identification, with critical and explanatory notes of the species belonging to this single genus. While only such species have been included as occur in Iowa, the treatment has in no other respect been of a local character. None of the species are peculiar to the state, and the majority have a wide range.

Probably the most marked deviation of the present paper from established ways is the attempt to combine the three equally prominent stages in the life cycle of each species into a single characterization. So far as the writer is aware it is the first time any portion of the American *Uredineæ* has been thus treated. It is customary to base species upon characters drawn from one or possibly two stages of the plant, and to distribute the stages under separate genera; and this is still the only method of disposing of many forms whose specific

relationship cannot at present be determined. It may be urged that granting the advantage in uniting the stages under a single name and set of characters, it ought to be deferred until the genetic relationship is definitely settled. But too great conservatism is often as serious hindrance to stable progress as a free interpretation, and especially so in the present matter. The only crucial test of actual relationship is that obtained by cultures. But, in the meantime, while waiting for the cultures to be made, it cannot be otherwise than profitable to tentatively unite forms that apparently belong together. When the teleutosporic stage is on a gramineous host, and in other very doubtful cases there is no alternative, however, but to wait for the experimental evidence.

Another feature of the paper, in contrast with general usage, is the uniformity and fulness of the descriptions, which it is believed will materially add to their value. The characters without exception have been directly derived from specimens in hand, which were mostly from the herbarium, and consequently dry. If fresh material is used some allowance is occasionally to be made for change of color. This is more particularly true of spores in the æcidial stage.

The synonymy has not been extended beyond the limit warranted by the library and exsiccati at command, but is nevertheless quite complete.

Care has been taken to make the measurements accurate. A fine Roger's stage micrometer, kindly loaned by Professor Bessey, was used to determine the value of the eye-piece micrometer, with which the measurements were made. The microscopic characters were ascertained with a No. 7 Hartnack objective, of about 140° angular aperture, and the minute characters of the spore surfaces were verified, when necessary, with a Tolles' 1-10 immersion lens, with angular aperture of 120°.

I cannot too heartily express my gratitude and indebtedness to Professor C. E. Bessey, of the Iowa Agricultural College, who placed his fine collections, library and apparatus, together with those of the college, at my disposal, without which the present paper could not have been prepared. I am also under obligations to Mr. E. W. Holway, of Decorah, Iowa, an enthusiastic observer and collector, for material and assistance. Dr. W. G. Farlow, of Harvard University, also favored me with portions of two specimens from his set of von Thümen's Mycotheca Universalis, which did good service.

The specimens of the Herbarium Curtis consulted were not numbered, and I have therefore given the names attached to the specimens in lieu of numbers.

UROMYCES HYPERICI-FRONDOSI (*Schw.*)

Æcidium Hyperici-frondosi Schw. Syn. Fung. Car. Sup., No. 451; Curtis in Plants of N. Car., 124.

Cæoma (*Æcidium*) *Hypericatum* (Lk.) Schw. Syn. Fung. Am. Bor., No. 2883; Link in Spec. Plant., II, 58.

Uredo (*Æcidium*) *Hyperici*, (Spr.) Sprengel in Linn. Syst. Veg., ed. 16, IV, 572.

Cæoma (*Uredo*) *Hyperici* Schw. Syn. Fung. Am. Bor., No. 2842.

Trichobasis Hyperici Gerard. Bull. Torr. Cl., IV, 47.

Æcidium minutissimum Gerard. Bull. Torr. Cl., V, 40.

Æcidium Hypericorum B. & C. Grevillea, III, 61.

Uromyces Hyperici Schw. Curtis in Plants of N. Car., 123; Farlow in Bull. Bus. Inst., I. 432.

Uromyces triquetra Cke. Jour. Port. Soc., I, 184; Cooke and Ellis in Grevillea, VI, 86.

EXSICCATI:

Herb. Curtis (*Uromyces Hyperici* (*Schw.*)

Ellis, N. Amer. Fungi, III, 231.

I. Æcidia collected into small groups of a dozen, more or less, which are scattered irregularly over the under surface of the leaf, or crowded and indistinguishable, minute, round; margin whitish, erect or revolute, slit into irregular teeth; spores polygonal-globose, rarely longer than wide, very minutely and unevenly warty, appearing nearly smooth under a lower power, pale or colorless, 15 to 20μ in diameter. II. Uredosori scattered over the surface of the leaf, minute, roundish, tardily naked; uredospores round, less commonly oblong or ovate, minutely echinulate or almost granulate, with short, thick points, light brown, 17 to 21μ broad by 17 to 25μ long. III. Teleutosporesori on all green parts of the host, dark brown or blackish, variable, (1) on the foliar organs, more or less roundish, from very minute up to a half millimeter in diameter, quite evenly scattered, or gathered into indefinite groups, distinct or confluent, cushion-shape, soon naked, encircling epidermis conspicuous, (2) on the stem elongated, from minute to a centimeter long, irregularly scattered or forming swollen girdles, tardily naked, surface plane or convex, epidermis conspicuous, sometimes slit into longitudinal shreds; teleutospores mostly ovate-wedge-shape to oblong-wedge-shape, but varying from nearly globose to linear-lanceolate, smooth, dark brown, size varying with the size of the sorus, (1) from the punctiform sori of the leaves 10 to 16μ broad by 16 to 25μ long, (2) from the girdle sori of the stems 12 to 17μ broad by 25 to 38μ long; wall quite thin; apex greatly thickened, usually up to 10μ thick, rarely up to 22μ thick, from truncate to broadly conical; base narrowed into the pedicel, or simply acute, or obtuse; pedicel slender, pale brown, once to twice the length of the spore.

On *Hypericum pyramidatum* Ait.; *H. corymbosum* Muhl. (Mass.); *H. mutilum* L. (Conn.); *Elodes Virginica* Nutt. (Me. and Mass.).

Ames, Decorah; Mass. (Farlow); Me. and Conn. (Herb. Curtis).

The first stage occurs from July to very late in autumn. The second and third stages soon follow upon the same host, and the three often continue to be produced side by side till frost kills them.

The æcidia are unusually small. In the earlier part of the season they are generally gathered into groups of a dozen or more, and accompanied by more or less discoloration of the

leaf, so as to be fairly conspicuous. Later in the season the discoloration becomes less, and the groups grow smaller and smaller, till only one or two æcidia are produced in a place. In this last state the æcidia might well be described as sparingly scattered over the whole lower surface of the leaf. This fact together with their minuteness renders them difficult to be seen without a hand lens, and is the condition on which Gerard founded his *Æ. minutissimum*, which he described from specimens gathered in October and November. I have examined this state upon *Hypericum corymbosum* and *H. mutilum*, in both instances where it was accompanied by the teleutospores. Schweinitz's original specimens for his description of stage I were on *Hypericum aureum* Barton, then known as *H. frondosum* Michx. I have seen no examples on this host. Link in the Species Plantarum changed the specific name to *Hypericatum* which was adopted by Schweinitz in the Fung. Am. Bor.

The uredo stage was first described by Gerard (l. c.) in 1873. The description for this stage as given above was taken from a specimen on leaves of *Elodes Virginica* from Maine in the Herb. Curtis. It was marked *Uredo Hypericorum* DC., a name that belongs to the European plant, which is undoubtedly distinct from the American. I have not seen good examples of uredosori on *Hypericum*, but have no reason to suppose they differ in any way from those on *Elodes*. Whether they ever occur upon the stems in a form corresponding to the cauline teleutosporesori, I do not know.

The variations in the size of the teleutospores is very remarkable. The larger ones are slimmer than the smaller, and often have the thickened apex excessively elongated. There is enough difference between the extreme forms to mark distinct species, if the intermediate grades did not occur. This difference has not been overlooked: Schweinitz's *Uredo*

Hyperici only embraces the teleutosporic form on the stems, while Cooke's *Uromyces triquetra* is the same on the leaves.

UROMYCES LESPEDEZÆ (*Schw.*)

Puccinia Lespedezæ Schw. Syn. Fung. Car. Sup., No. 497 and 498; Syn. Fung. Am. Bor., No. 2940 and 2941; Sprengel in Linn. Syst. Veg., IV, 568.

Uromyces macrospora B. & C. Peck in 23d Rep. N. Y. St. Mus., 58; Farlow in Bull. Bus. Inst., I, 432.

Uromyces Lespedezæ Peck. 29th Rep. N. Y. St. Mus., 68; Bot. Gaz., I, 20; Cooke and Ellis in Grevillea, VI, 86.

EXSICCATI:

Herb. Curtis.

Ravenel, Fungi Am. Exsic., V, 494.

Ellis, N. Am. Fungi, III, 245.

I. Not seen. II and III. Sori scattered over the surface of the leaf, largely beneath, roundish, soon naked; encircling epidermis inconspicuous; bounded by colorless paraphyses which are linear, more or less curved, rounded at the apex, with walls so much thickened as to nearly or quite obliterate the cavity, 6 to 10μ broad by 50μ long. II. Uredosori very small, pale yellowish, inconspicuous; uredospores oblong-ovate to globular, minutely and abundantly echinulate with very short points, pale yellow, 15 to 20μ broad by 16 to 21μ long; wall thin. III. Teleutosporesori small, cushion-shape, blackish; teleutospores lanceolate-oblong, sometimes ovate-elliptical, smooth, brown, 12 to 15μ broad by 23 to 35μ long; wall rather thin; apex much thickened, obtuse or rarely acutish, from broadly rounded to cone-shape, dark brown with the tip lighter, 12 to 16μ thick; base narrowed or somewhat obtuse; pedicel once to twice the length of the spore, slender, colorless.

On *Lespedeza capitata* Michx.; *L. leptostachya* Engelm.; *L. hirta* Ell. (S. Car.); *L. violacea* Pers. (S. Car. and N. Car.); *L. repens* Barton (S. Car.).

Charles City, Ames, Ft. Dodge, Emmett Co., Lyons Co.; S. Car. (Ravenel); N. Car. (Ravenel); Mass. (Farlow).

Stage I is doubtless what usually is called *Æcidium leucostictum* B. & C., of which I have seen no specimens.

Stages II and III are very abundant in August and September. The former has not attracted much attention, however, and does not seem to have been described.

The third stage forms larger sori on the coarser and larger-leaved hosts than on the smaller kinds. The first have rather longer spores, with the apex more strongly thickened. This difference between the larger and smaller forms furnished the chief reason for the separation of the two species which were recognized by Schweinitz and later authors. Of the hosts cited, *L. repens* bears the smallest form, and *L. capitata* the largest. Schweinitz's first specimens were upon *L. repens*, then known as *L. procumbens*, and on *L. hirta*, then known as *L. polystachya*. He consequently called his two supposed species *Puccinia Lespedezæ-procumbentis* and *P. Lespedezæ-polystachyæ*. He subsequently discovered that the latter form was more common on *L. violacea* than on *L. hirta*, and for this reason changed the name to *P. Lespedezæ-violaceæ*. Owing to this multiplicity of names for the same thing, and the objectionable character of each of them when written in full, it is living up to the spirit of the "Laws of Botanical Nomenclature," if not quite to the letter, to adopt and use only the first half of the various specific names. This has been the practice for some time, but was first definitely advocated by Peck (l. c.). The bilocular character of the spores which caused Schweinitz to refer his plants to *Puccinia*, and helped to nominally separate his two species, were drawn from an optical illusion. Under a magnifying power of 75 to 100 diameters, and without moisture, which is probably the way in which Schweinitz made the examination, the thickened apex is readily mistaken for another cavity of nearly the same size as the real one*. European authors of the time were

* For the method to be used in interpreting the descriptions of early authors see American Naturalist for January, 1883.

evidently much in doubt regarding Schweinitz's two species. Link quoted them both under *Puccinia Fabæ*, while Sprengel united the two and gave the name of *Puccinia Lespedeziæ*.

UROMYCES HEDYSARI-PANICULATI (*Schw.*)

Puccinia Hedysari-paniculati Schw. Syn. Fung. Car. Sup., No. 503.

Phragmidium Hedysari Schw. Syn. Fung. Am. Bor., No. 2947.

Uromyces solida B. & C. Grevillea, III, 57; Curtis in Plants of N. Car., 122.

Uromyces Desmodii Thuem. Bull. Torr. Cl. VI, 215.

Uromyces Desmodii Cooke. Hedwigia, Mar. 1878, 39.

EXSICCATI.

Herb. Curtis (*Uromyces solida* B. & C.)

Ravenel, Fungi. Am. Exsic., I, 49, and V, 493.

Ellis, N. Am. Fungi, III, 246.

I. Not seen. II and III. Sori small, scattered or in indefinite clusters, round, or nearly so, very soon naked; surface loose; encircling epidermis inconspicuous. II. Uredosori yellowish-brown; uredospores nearly globular, rarely elliptical, and more rarely pear-shape, very minutely and thickly echinulate, yellow, 18 to 22μ wide by 18 to 24μ long. III. Teleutosporesori dark brown; teleutospores elliptical, oblong, or oblong-ovate, of a uniform dark reddish-brown, coarsely and evenly granular, including the apex, 15 to 20μ wide, by 20 to 28μ long; walls quite thick; apex obtuse, somewhat thickened, rarely smooth; base rounded; pedicel twice or thrice the length of the spore, colorless, or slightly brownish next the spore, delicate, rather thick, of uniform diameter.

On *Desmodium sessilifolium* T. & G.; *D. canescens* DC. (S. Car.); *D. strictum* DC. (S. Car.); *D. paniculatum* DC. (S. Car.).

Ames; New Jersey (Ellis); Penn. (Herb. Curtis); Ala. (Herb. Curtis); S. Car. (Ravenel).

Schweinitz must have placed this species under *Puccinia* principally on account of the shape and color of the teleutos-

pores, and assumed the presence of a septum. He says "*septum non conspicuo*," which is true, as there is no septum whatever. Link appended it in a note to *Cœoma appendiculosum* (Spec. Plant., II. 33.) Schweinitz in his later work, The North American Fungi (l. c.), ignores Link's disposition of it, and puts it with some doubts under *Phragmidium*, but he was not well acquainted with this genus, and had not seen examples of it, at least not American specimens. His first specimens were on *Desmodium paniculatum*, then known as *Hedysarum paniculatum*, but as he afterwards received the same thing from the Northern States on other species of *Desmodium* also, he dropped the second part of the specific name in his later work. Sprengel referred it to *Uredo appendiculata* Pers. in Linn. Syst. Veg., IV, 577. The descriptions of *U. Desmodii* by both Cooke and von Thümen were published in March, of 1878—a curious coincidence when the circumstances attending their publication are considered. There is no appreciable difference between the two examples of the species in Ravenel's Exsiccati, although one is published under the name of *Uromyces solida* B. & C., and the other under *U. Desmodii* Cke. The plant is apparently not very abundant, as it has only been collected once in the state, at Ames, in September, 1878.

Uromyces Phaseoli *Wintr.*

Uromyces Phaseoli (Pers.) Winter. Rabh. Kryp. Fl. v. Deutschl., I, No. 209.

Cœoma (*Uredo*) *Leguminosarum* Link. Spec. Plant., II, 34; Schweinitz in Syn. Fung. Am. Bor., No. 2847; Curtis in Plants of N. Car., 122.

Uromyces appendiculatus Lev. Farlow in Bull. Bus. Inst., I, 432; Cooke in Handb. Brit. Fung., II, 518 in part; Cooke in Micros. Fungi, 2d ed., 211 in part.

Uromyces phaseolorum De Bary. Cooke in Grevilles, VII, 135; Fuckel in Symb. Myc., 62.

Exsiccati:

Herb. Curtis (*Uredo Leguminosarum* Lk., and *Uromyces Phaseoli* (Str.).

Ellis, N. Am. Fungi, III, 243.

Ravenel, Fung. Am. Exsic., V, 495.

Thümen, Myc. Univers., 1039.

I. Æcidia closely aggregated in roundish clusters, which are distributed without order over the lower surface of the leaf on large yellow spots that are more or less confluent, small; margin prominent, revolute, slit into numerous minute irregular teeth; spores polygonal-globose or somewhat longer than wide, nearly colorless, finely and unevenly warty, 17 to 25μ broad by 20 to 25μ long. II and III. Sori scattered over the whole surface of the leaf, roundish, at first cushion-shape, after rupturing plane or concave, soon naked; encircling epidermis conspicuous. II. Uredosori light brown; uredospores roundish or oblong, or rarely elliptical or ovate, minutely and moderately echinulate, yellow or brownish-yellow, 17 to 22μ wide by 21 to 28μ long. III. Sori brown; teleutospores nearly round to broadly elliptical or oblong, smooth, or rarely with a few scattered warts, uniform brown, 21 to 25μ wide by 28 to 35μ long; walls thick; apex bearing a light-brown obtuse papilla which is broader than high, 10μ thick or less; base semicircular; pedicel slender, colorless, rarely exceeding one-half or two-thirds the length of the spore.

On *Phaseolus diversifolius* Pers.; *Apios tuberosa* Mœnch.; *Amphicarpæa monoica* Nutt.

Decorah, Ames; New Jersey (Ellis); Rhode Island (Herb. Curtis); S. Car. (Ravenel); Europe.

The æcidium stage occurs on *Apios* and *Amphicarpæa* in June; it also occurs on *Phaseolus*, but I have seen no specimens. The warts on the æcidiaspores are of unequal size, either few or abundant, and are frequently disposed in a well marked zone. I have been unable to consult any authenticated specimens of æcidia belonging to this species, and consequently have been obliged to determine the Iowa specimens by means

of descriptions alone. For the same reason I am not sure under what name the American plant has been distributed, but quite likely under *Æ. Leguminosatum* Lk., although that on *Amphicarpæa* has been sometimes referred to *Æ. Orobi* Pers.

The uredo and teleutospore stages were examined on *Phaseolus diversifolius* from Iowa and New Jersey, *P. lunatus* from S. Carolina, and on several undetermined specimens of *Phaseolus* from S. Carolina, Rhode Island and Europe. The teleutospore stage on an undetermined species of *Phaseolus* in the Ravenel Exsiccati, and which does not differ in any way from other specimens, is ticketed *Urom. phaseolorum* De Bary. A similar specimen on *P. lunatus* in Herb. Curtis is called *Urom. Phaseoli* (Strauss). No. 1039 of von Thümen's Mycotheca Universalis, showing both uredo and teleutospores, differs in no important respect from the American plant. The *Uredo Fabæ* on *Amphicarpæa* in Herb. Curtis does not belong to the *Uredineæ*, but is a species of *Synchitrium*. I have seen no examples of stages II and III on *Apios* and *Amphicarpæa*, if such occur. Occasionally the teleutospores have a portion of the pedicel next the spore remaining firm and slightly colored in such a way as to imitate in size and appearance the papillæ at the apex.

UROMYCES OROBI *Wintr.*

Uromyces Orobi (Pers.) Winter. Rabh. Kryp. Fl. v. Deutschl., I, No. 210.

Uromyces polymorphus P. & C. 31st Rep. N. Y. St. Mus., 43.

Æcidium porosum Peck. Bot. Gaz., III, 34.

EXSICCATI:

Thümen, Myc. Univers., 1038.

I. Æcidia scattered quite evenly over the whole under surface of the leaf, intermixed with spermagonia, round, or compressed in direction of the veins; margin conspicuous,

whitish, revolute, with both large and small irregular teeth; spores polygonal-globose or polygonal-oblong; smooth, or under a high power minutely granulate, nearly colorless, 16 to 22μ broad by 20 to 25μ long. II and III. Sori irregularly scattered over both sides of the leaf, roundish, low-cushion-form, soon naked. II. Uredosori yellowish-brown; encircling epidermis noticeable; uredospores pear-shape, elliptical, or shortened to nearly globose, minutely echinulate, light brown, 15 to 22μ broad by 22 to 32μ long. III. Teleutosporesori blackish-brown; teleutospores variable in shape, mostly wedge-obovate or ovate-oblong, smooth, dark-brown, 17 to 22μ broad by 25 to 35μ long; wall rather thin; apex greatly thickened, 5 to 7½μ thick, obtuse, varying from truncate or rounded to broadly conical; base broadly acute; pedicel once to twice as long as the spore, stout, slightly brownish especially next the spore.

On *Vicia Americana* Muhl.; *Lathyrus venosus* Muhl.; *L. ochroleucus* Hook. (New York).

Decorah, Ames; New York (Peck); Europe.

Stage I occurs in May and June. Examples upon *Vicia Americana* only have been examined; whether it has yet been found upon *Lathyrus*, I do not know. The leaves of the host are not distorted by the parasite, although the æcidia are usually very abundant, and intermixed with numerous sperm-agonia.

The uredosori were found on *Vicia* late in October, quite free from any intermixture of teleutosporesori. They were examined both fresh and dry. Uredosori on *Lathyrus* were not obtained, although a few scattering uredospores were observed among the teleutospores.

The third stage was gathered on separate plants of *Vicia* about the same time as the uredosori just mentioned. It was also examined in the dry state on *Lathyrus venosus*. Peck's description of *U. polymorphus* was drawn from specimens upon *Lathyrus ochroleucus* from Buffalo, N. Y., a host on which I have seen no examples. So far as observed, more of the teleutospores on *Lathyrus* are deformed and of irregular

shapes than on *Vicia*, and better warranted the specific name of *polymorphus*.

UROMYCES HOWEI (Pk.)

Trichobasis Howei Peck. 23d Rep. N. Y. St. Mus., 58.
Uromyces Howei Peck. 30th Rep. N. Y. St. Mus., 75.
Uromyces Asclepiades Cooke. Grevillea, V, 152.
Æcidium Jamesianum Peck. Bot. Gaz., V, 34.
EXSICCATI:
Ellis, N. Am. Fungi, III, 235.

I. Æcidia in orbicular groups on the under surface of the leaf, upon discolored spots, sometimes in partial circles, small, cylindrical; margin white, recurved, ragged, or with a few irregular lobes; spores polygonal-globose, rarely a little longer than wide, smooth, colorless, 17 to 22μ in diameter; wall greatly thickened internally on one side, usually occupying a third of the spore-cavity. II. Uredosori yellowish-brown; uredospores round or slightly longer than wide, abundantly echinulate with short slender needle-like points, light clear yellow or brownish-yellow, 22 to 27μ in diameter. III. Teleutosporesori scattered over the under surface of the leaf, few or indefinitely numerous, in places somewhat aggregated and confluent, small, roundish, soon naked, surface pulverulent; encircling epidermis conspicuous unless hidden by the pubescence of the leaf, dark or chocolate brown; teleutospores mostly globose, but varying to oblong, obovate, or pear-shape, minutely and evenly granulate, uniform brown, 18 to 23μ broad by 20 to 30μ long; wall not very thick; apex not thickened, semicircular; base like the apex, or sometimes obtuse, or even acute; pedicel slender, colorless, rarely exceeding half the length of the spore, often much shorter, or wholly disappearing.

On *Asclepias Cornuti* Dec.; *A. incarnata* L.; *A. tuberosa* L. Decorah, Ames; Mass. (Farlow); New York (Peck); Maine (Cooke).

Stage I has been examined on *Asclepias tuberosa* and *A. Cornuti*. It does not appear to be very abundant. Spermagonia are numerous on the dark spots upon the upper surface of the leaf, are quite blackish, and usually stand close together. The æcidiaspores are very uniform in size and

appearance. The internal thickening of the wall is an unique character, and apparently constant. About a quarter of the wall-surface is several times thickened, and bulges into the cavity of the spore, leaving the rest of the wall unchanged. The external outline of the spore is not at all affected. As the spores are examined under the instrument, the thickened portion frequently lies directly above or below and is detected with difficulty, but by moving the cover-glass so the spore will roll over, it is brought into view.

I have seen only a few over-ripe sori of stage II, which stood among crowded sori of stage III, and cannot therefore give the characters in full. The color of the two is quite distinct: the former is lighter and more inclined toward yellow, being nearly a sienna brown, while the latter is darker and has a strong reddish cast. Both are warm rich colors. The uredospores are large and quite unlike the teleutospores, and it is odd that no author has mentioned them. Peck's first description, although he called the plant *Trichobasis*, refers to the teleutosporic stage. He afterward changed the genus to *Uromyces* on the ground that the pedicels although "very short and obscure are permanent."

The sori of stage III are small, or even very minute. They are sometimes dotted sparingly over the lower surface of the leaf, but are oftener crowded together in the greatest profusion; a few are occasionally to be found on the upper surface. The ruptured epidermis cannot readily be seen on leaves of *A. Cornuti*, on account of the close pubescence. I find no record of its occurrence on any other species of milkweed than the one just mentioned. Mr. Holway, however, sends it from Decorah on *A. incarnata*. The sori are a little larger than on *A. Cornuti*, and are gathered into a few indefinite clusters; otherwise the specimens do not differ. The surface of the sori have a pulverulent appearance soon after

becoming exposed, caused by the spores breaking loose through the extreme brittleness of the pedicels. As the pedicel is liable to break at any point the part that remains attached to the spore is, consequently, often very short, or is quite wanting. Sometimes the part that remains exactly simulates a small papilla, and should not be mistaken for the colorless papilla that is to be seen in rare instances at the apex of the spore.

UROMYCES EUPHORBIÆ. (*Schw.*)

Æcidium Euphorbiæ (Schw.) Syn. Fung. Car. Sup., No. 455.

Uredo Euphorbiæ (Schw.) Syn. Fung. Car. Sup., No. 459.

Cæoma (*Æcidium*) *Euphorbiæ-hypericifoliæ* Schw. Syn. Fung. Am. Bor., No. 2890.

Uromyces Euphorbiæ C. & P. 25th Rep. N. Y. St. Mus., 90; Farlow in Bull. Bus. Inst., II, 225.

EXSICCATI:

Herb. Curtis (*Uromyces Euphorbiæ-hypericifoliæ* (Schw.).

Ellis, N. Amer. Fungi, III, 236.

Ravenel, Fungi Am. Exsic., V, 484, 492.

I. Æcidia scattered over the whole under surface of the leaf, and sometimes over the upper, roundish, shallow, hemispherical before rupturing; margin whitish, erect or slightly recurved, minutely jagged; spores polygonal, nearly globular, or rarely longer than wide, very minutely granular, appearing smooth under a lower power, pale yellow, 12 to 17μ in diameter. II and III. Sori roundish or irregularly oblong, scattered without order, soon naked, plane or slightly convex; encircling epidermis conspicuous. II. Uredosori light brown; uredospores nearly or quite round, sometimes oblong, finely and abundantly echinulate with short needle-like points, yellow or brownish-yellow, 15 to 20μ broad by 15 to 23μ long. III. Teleutosporesori medium or dark brown, rarely yellowish; teleutospores nearly round, elliptical, oblong, pear-shape, obovate, or ovate, usually all forms in the same sorus,

evenly granulate with fine papillæ, medium or dark brown, 15 to 18μ broad by 19 to 25μ long; wall thin; apex rounded or obtuse, not at all or slightly thickened; base rounded, sometimes narrowed; pedicel colorless, very slender, short, rarely longer than the spore.

Var. MINOR (*n. v.*) Teleutospores smaller and rounder, 15 to 17μ broad by 15 to 22μ long, with less prominent papillæ, or nearly smooth.

On *Euphorbia maculata* L.; *E. glyptosperma* Engelm.; *E. hypericifolia* L.; *E. heterophylla* L. The variety on *E. marginata* Pursh.

Ames, Charles City, Decorah; New York (Peck); Mass. (Farlow); New Jersey (Ellis); S. Car. (Ravenel); Minn. (Arthur).

This appears to be a distinctively American species. It was first recorded by Schweinitz in 1822 in his Synopsis Fungorum Carolinæ Superioris. He distinguished two sorts, one on *Euphorbia maculata*, and the other on *E. hypericifolia*.

Stage I on *E. maculata* is very common throughout the northern states and westward at least as far as Iowa and Minnesota. It does not appear to have been seen by Schweinitz on this host, but was noted on *E. hypericifolia*. In his earlier work he catalogued it under *Æ. Euphorbiæ* (No. 455), without giving credit for the name, which may indicate that he thought it possibly identical with Persoon's species of the same name. He quite distinguishes it as his own, however, by observing that it does not change the nature of the leaves upon which it is parasitic (*sed non degenerantem reddit*). This separates it at once from the European æcidia on *Euphorbia*, all changing the shape, thickness, and appearance of the infested leaves. This subsequently became clear to Schweinitz, who accordingly gave a full description in his later work (l. c.), and of necessity changed the name. No. 484 of Ravenel's F. Am. Exsic. labelled *Æ. Euphorbiæ* P. is evidently an attempt to follow the authority of Schweinitz, although the host is *E. maculata*. The plant is much less abundant on *E. hypericifolia*.

folia than on *E. maculata* and the very similar *E. glyptosperma*, at least northward. It reaches the fullest development in June, but may be found till frost comes. The prostrate species of *Euphorbia* have the habit changed by the *Uromyces*, more especially by the æcidia, and become erect, with longer internodes and a pale sickly hue. Only the branches bearing the parasite exhibit this change, and if any branches remain free from it they are quite normal in appearance and deportment, even on small plants.

The spores of stages II and III are much alike, and often approach one another closely in color, size, form, and surface. For this reason, doubtless, the two have not been separately described, and it may sometimes be uncertain which stage was under examination. It is presumable, however, that the teleutospores are always intended. Schweinitz was the first observer. He records *Uredo Euphorbiæ* on *E. maculata* in his earlier work (l. c.), but without signature. This is placed under the section "Rubigo," with the remark that it is not rare, but strangely enough is not mentioned in his later work, the Synopsis Fungorum in America Boreali. That on *E. hypericifolia* is referred in the earlier work to *Uredo scutellata* (No. 474), and transferred in the later work to *Cæoma punctuosum* Lk. (No. 2846). I have not examined Schweinitzian specimens of this, but Dr. Farlow has been able to do so (Bull. Bus. Inst., II, 245), so far as to identify it with the common form, which is at present to be considered distinct from the European species. Curtis was evidently puzzled regarding the determinations of Schweinitz, for in his list he calls it a form of *U. apiculosa*, while in his distribution a specimen is marked *U. Euphorbiæ-hypericifoliæ* (Schw.). The former is incorrect, and the latter must be also if we consider, as Curtis did, that the æcidial and teleutosporic forms belong to separate genera. I have not had opportunity to examine the

Trichobasis Euphorbicola B. & C., No. 598 of the Fungi Cubenses, or Berkeley's description in Jour. Linn. Soc., 357, but doubt not that they refer to the plant under discussion. The latest name is *Urom. Euphorbiæ* by Cooke and Peck (l.c.), 1872. There is considerable resemblance between our plant and the European *U. scutellatus*, well described by Winter in Rabenhorst's Kryp. Fl. v. Deutschl., I, No. 185 (1881), but so far as one can judge from descriptions they are not identical.

This in brief is the history of the synonymy. In order to avoid the objectionable compound name given by Schweinitz in his later work, the earlier specific name used by him for both stages is adopted. For although he did not stamp these at the time as positively new species, he subsequently discovered them to be such, and only changed the name, as we may infer, because it was then preoccupied. This objection does not now hold. The mature stage of the species has, moreover, been since redescribed under this earlier name, and it is in general use for both that and the æcidial stage, all favoring its adoption.

The uredo and teleutospore stages are common from July to October. The prickles on the uredospores are sometimes feebly developed, and occasionally wanting on individual spores.

The variety on *E. marginata* was obtained from plants grown in the garden at Ames, although the host is a native of western Iowa, and westward. No uredo or æcidia were seen. The teleutosporesori are in the centre of conspicuous yellow spots (2 to 4 mm. broad); the teleutospores also have a distinct appearance depending on the characters cited. The so-called *Urom. myristica* on *E. bicolor* of Texas, I have not seen, but it is not considered a distinct species by Farlow (Bull. Bus. Inst., II, 245).

UROMYCES POLYGONI *Wintr.*

Uromyces Polygoni (Pers.) Winter. Rabh. Kryp. Fl. v. Deutschl., I, No. 203.

Puccinia Vaginalium Link. Spec. Plant., II, 69; Cooke in Handb. Brit. Fungi, II, 495.

Uromyces Polygoni Fuckel. Symb. Myc., 64; Cooke in Handb. Brit. Fungi, II, 519; Cooke in Micr. Fungi, 2nd ed., 225; Peck in 24th Rep. N. Y. St. Mus., 89.

Uromyces Aviculariæ Schrœt. Cooke in Grevillea, VII, 136.

EXSICCATI:

Herb. Curtis (*Puccinia Aviculariæ* Pers.).

Ellis, N. Am. Fungi, III, 237.

I. Æcidia not seen. II and III. Sori scattered over the leaves and stems, round, soon naked; encircling epidermis conspicuous; surface convex. II. Uredosori light brown; uredospores globose, or rarely oblong or ovate, smooth, or under a very high power thickly beset with extremely fine needle-like points, brownish yellow, 19 to 25μ broad by 21 to 28μ long. III. Teleutosporesori elongated on the midrib and stem, dark brown; teleutospores varying through all degrees from obovate and globose to oblong and elliptical, smooth, golden brown, 16 to 20μ broad by 23 to 38μ long; wall rather thin; apex rounded or sometimes flattened or obtuse, darker colored, from 2 to 6μ thick; base rounded, obtuse, or acute; pedicel two to four times as long as the spore, of uniform diameter, 6μ wide, nearly colorless.

On *Polygonum aviculare* L.; *P. erectum* L.

Charles City, Ames; Mass. (Farlow); Europe.

The æcidial condition is to be found, according to Fuckel (l. c.), on the very young host plants. I am not aware that it has been recorded in the United States; but it will doubtless be found when searched for.

Stages II and III are much more abundant on *Polygonum erectum* than on *P. aviculare* in Iowa. On the former host they are so numerous often as to give it a very rusty appear-

ance, while on the latter, so far as I have observed, they are few and scattered. They occur from August to October. The one on *P. aviculare* has rather shorter and more globose teleutospores. The echinulation of the uredospores is remarkable for its abundance and minuteness, and is easily mistaken for a minutely granular surface. The specimen in the Herb. Curtis is from France, collected by Roberge, but does not differ from American specimens.

UROMYCES CALADII (*Schw.*)

Æcidium Caladii Schw. Syn. Fung. Car. Sup., No. 457.
Uredo Caladii Schw. Syn. Fung. Car. Sup., No. 480.
Cæoma Aroidatum Link. Spec. Plant., II, 43.
Cæoma Caladii Link. Spec. Plant., II, 9.
Cæoma (*Æcidium*) *Aroidatum* Schw. Syn. Fung. Am. Bor., No. 2860.
Cæoma (*Uredo*) *Ari-virginici* Schw. Syn. Fung. Am. Bor., No. 2839.
Cæoma (*Æcidium*) *Dracontinatum* Schw. Syn. Fung. Am. Bor., No. 2861.
Puccinia Ari-triphylli Schw. Syn. Fung. Am. Bor., No. 2946.
Uredo Caladii Sprengel. Linn. Syst. Veg., ed. 16, IV, 574.
Uromyces Peltandræ Howe. Bull. Torr. Cl. V, 3, 43; Peck in 29th Rep. N. Y. St. Mus., 67.
Uromyces Pontederiæ Gerard. Bull. Torr. Cl. VI, 31, 78.
Uromyces Arisæmæ Cooke. Bull. Torr. Cl. VI, 32.
Uromyces Ari (Schw.) Farlow in Bull. Bus. Inst., I, 432.

EXSICCATI:

Herb. Curtis (*Æcidium Aroidatum* Schw.)
Ellis, N. Am. Fungi, III, 232, 233.

I. Æcidia scattered without order over the green parts of the host, or collected in indefinite patches, not in groups, most

abundant on the lower surface of the leaves, spermagonia intermixed or separate on the same surface, round, or compressed on the petiole and stem, hemispherical before rupturing; margin delicate, erect or sometimes revolute, finely or coarsely eroded, rarely with deep slits; spores polygonal-globular, or a little longer than broad, apparently smooth, but under a higher power finely and evenly granulose, nearly colorless, 14 to 20μ broad by 18 to 25μ long. II and III. Sori scattered over both surfaces of the leaf, more or less confluent, roundish, small, tardily naked; encircling epidermis conspicuous, grayish lead-color before rupturing. II. Uredosori light brown; uredospores round, oblong, or obovate, moderately and somewhat unevenly echinulate, under a higher power with the rather stout points standing upon more or less prominent elevations of the surface, pale yellow, 17 to 25μ broad by 25 to 37μ long. III. Teleutosporesori medium brown; teleutospores elliptical to obovate, smooth, light yellowish-brown, 19 to 23μ broad by 23 to 35μ long; wall rather thin; apex semicircular or broadly rounded, not thickened but with a blunt light-colored papilla not exceeding 5μ high and about as broad as high, not rarely with two or more such papillæ on the upper half of the spore; base sometimes narrowed, usually semicircular or very obtuse; pedicel colorless, delicate, about as long as the spore, deciduous and very rarely seen, a part of the pedicel about as large as the papilla at the apex of the spore usually persistent.

On *Arisæma triphyllum* Torr.: *A. Dracontium* Schott; *Peltandra Virginica* Raf. (Mass.).

Charles City, Ames, Decorah, Manchester; Mass. (Farlow); New York (Herb. Curtis).

Stage I is quite common in May, and often infests the whole aerial surface of the host, even to the spathe. The æcidia have a characteristic appearance when dry, but one not readily described.

Stages II and III appear in July. The sori are usually more numerous on the upper surface of the leaf than on the lower. The uredospores sometimes show a semilunar thickening of the wall at one end, after the manner of some teleutospores; while the points upon the surface of the spore, which are evidently rather brittle, have frequently so far disappeared as to leave it but little roughened.

The characters given above are drawn entirely from specimens on the two species of *Arisæma* cited. The same species on *Peltandra* shows some divergence from the typical form, the spores of the three stages being somewhat larger, but especially the æcidiaspores, which measure 15 to 21μ broad by 25 to 35μ long, and are also more oblong and angular than the typical. Æcidiaspores of the two forms mixed together upon the same slide can be distinguished with ease and certainty, but the difference between the uredo and teleutospores of the two is far less noticeable. Whether we should set off this form as the variety *Peltandræ* is a disputable question which need not be answered here.

I give *U. Arisæmæ* Cke. as a synonym on the authority of Peck (l. c.) who says he does not consider it a distinct form.

UROMYCES JUNCI *Tul.*

Uromyces Junci Tul. Farlow in Proc. Am. Acad., XIII, 262; Cooke in Grevillea, VII, 139.

Uromyces Junci (Desm.) Winter. Rabh. Kryp. Fl. v. Deutschl., I, 162.

Puccinia Junci Schw. Syn. Fung. Am. Bor., No. 2913.

Puccinella Junci Fuckel. Symb. Myc., 60.

EXSICCATI:

Ellis, N. Am. Fung., III, 238.

Ravenel, Fungi Am. Exsic., I, 51.

I. Æcidia uncertain. II and III. Sori oblong or linear, scattered or in indefinite groups, small, rather tardily naked; encircling epidermis conspicuous. II. Uredosori light yellow, oblong; uredospores irregularly rounded or oblong to obovate, minutely echinulate, or nearly smooth, brownish-yellow, 14 to 19μ broad by 18 to 27μ long. III. Teleutosporesori more or less elongated, dark brown; teleutospores obovate, wedge-shape, or club-shape, sometimes rounded or elliptical, smooth, dark brown, 15 to 20μ broad by 25 to 40μ long; wall thin; apex 6 to 8μ thick, or rarely more, broadly rounded, truncate,

or rarely triangular-cone-shape; base narrowed into the pedicel; pedicel equal to or shorter than the spore, brownish.

On *Juncus tenuis* Willd.; *J. effusus* L. (Mass. and S. Car.).

Ames; Mass. (Farlow); S. Car. (Ravenel); Europe.

It is very doubtful what particular *Æcidium* should be associated with this species.

The Iowa specimens of stages II and III, gathered at Ames in September and October, are on *J. tenuis*, while all other specimens that have been consulted are on *J. effusus*. The two appear to differ somewhat, although the specimens on *J. tenuis* were not in good condition for comparison, being largely destroyed by a sphæriaceous parasite. This difference is especially evident in the sori, which are smaller on *J. tenuis* and not collected into groups, and in the more irregular and angular teleutospores, posessing a much more attenuated base. Both forms are united in the above description. A species of *Puccinia*, not determined, is mixed with the *Uromyces* on *J. tenuis*, but the teleutospores of the two genera are never found in the same sorus, and undoubtedly have no genetic connection. The epidermis covering the *Puccinia* sori, instead of being everted as in the *Uromyces* is split several times lengthwise, and the teleutospores protrude through the slits.

I have not had facilities to trace the early synonymy of the species, and have therefore accepted the conclusion of Dr. Farlow (l. c.), without giving full citation.

UROMYCES ACUMINATUS (*n. sp.*)

I. Unknown. II and III. Sori linear, narrow, elongated, on the under surface of the leaves, plane or slightly convex, sunken, soon naked; encircling epidermis somewhat conspicuous. II. Uredosori yellowish, inconspicuous; uredospores large, round or elliptical, finely and plentifully echinulate, brownish-yellow, 22 to 30μ broad by 26 to 35μ long.

III. Teleutosporesori brownish-black; teleutospores oblong-club-shape and oblong-lanceolate to obovate, smooth, golden-brown, darker at the apex, 15 to 22μ broad by 25 to 42μ long; wall thin; apex much thickened, 8 to 12μ thick, more or less obliquely acuminate, or rarely only apiculate, sometimes with two pointed terminations, one longer than the other, very rarely obtuse or rounded; base narrowed or only acute; pedicel of uniform thickness, as long as the spore, or shorter, very rarely longer, colored.

On *Spartina cynosuroides* Willd.

Ft. Dodge, Decorah, Spirit Lake.

In the specimens examined the under surface of the leaves is quite covered with the sori: that is, the spaces between the firm nerves are occupied, for the sori are largely below the level of the general surface of the leaf. The thin wall and thick pointed apex of the teleutospores sufficiently distinguish this from the *Uromyces* on *Spartina stricta*, which is also in other respects quite different. A specimen in the Herb. Curtis on *Rhynchospora paniculata* from S. Carolina, labelled *Puccinia Caricis* DC., is much like it in the characters of the teleutospores, but which, nevertheless, are slenderer with more delicate and longer pedicels. The Curtis specimen is a true *Uromyces*, but I am uncertain about the species. The specimens from Ft. Dodge were gathered early in September, and had a very few uredosori; the Decorah and Spirit Lake specimens were gathered in November and December, all in 1882.

Uromyces Brandegei *Peck.*

Uromyces Brandegei Peck. Bot. Gaz., IV, 127.

I. Æcidia unknown. II and III. Sori elliptical or oblong, irregularly scattered, tardily naked; encircling epidermis inconspicuous. II. Uredosori on the upper surface of the leaf, seated on yellow spots, small, yellow; uredospores round, oblong, or elliptical, rarely egg-shape, very minutely and sparingly echinulate, or quite smooth, orange-yellow, 15 to 25μ broad by 20 to 30μ long; wall very thin; paraphyses numerous, intermixed with the spores, slender club-shape with slight

constriction near the upper end, varying to capitate with a thick stalk, colorless, with thick walls and rounded apex, 13μ broad at the upper end by 38 to 75μ long. III. Teleutosporesori on both surfaces of the leaf, blackish; teleutospores globose-obovate or globose-oblong, very uniform in size and shape, thickly and evenly covered including the apex with small papillæ, dark brown, 25 to 30μ broad by 30 to 38μ long; wall rather thick, deeper brown; apex strongly thickened, 10 to 15μ thick, semicircular; base rounded or very obtuse; pedicel colorless, once to thrice the length of the spore, attenuated downwards.

On *Bouteloua curtipendula* Gray.
Decorah, Ames; Colorado (Peck).

This species is quite different from any with which I am acquainted. It is closely related by the characters of the sori and paraphyses, and the shape and size of the spores to *Urom. Dactylidis* Otth., but differs widely in other respects, especially in the surface of the spores and in the pedicel. The third stage only was described by Peck. The second stage was found at Ames in October, 1882, but unaccompanied with teleutosporesori. It was almost entirely confined to the radical leaves of the host; and was very abundant. Stage III has been collected at both Ames and Decorah, and the plant is doubtless abundant throughout the state. The uniformity of the teleutospores, their color and sculptured surface, make this an unusually beautiful species.*

* While this paper is passing through the press the eleventh century of Ellis' North American Fungi has been received, No. 1051 of which is a new species of *Puccinia—P. vexans* Farlow—on *Bouteloua curtipendula*, the specimens being from Decorah, Iowa. The special interest in this connection lies in the fact that many of the teleutospores of this *Puccinia* are single-celled and are of the same size, shape and color as those of *Uromyces Brandegei;* and, furthermore, the two are often so intimately associated as to be intermixed in the same sorus. They can readily be distinguished, however, by the character of the surface, the *Puccinia* spores being quite smooth. The description of the species is not yet published, and I am not aware whether the uredo stage has been identified or not.

INDEX TO UREDINEÆ.

INDEX TO SUPPORTING PLANTS.